PATENT SPECIFICATION

DRAWINGS ATTACHED

897,066

Date of Application and filing Complete Specification June 1, 1959.

No. 18525/59.

Application made in Germany on June 9, 1958.

Complete Specification Published May 23, 1962.

Index at acceptance:—Class 80(1), G7B5.

International Classification:—F06h.

COMPLETE SPECIFICATION

Improvements in or relating to power transmission gearing

We, ZAHNRAEDERFABRIK RENK AKTIENGESELLSCHAFT, of 71—81, Goegginger Strasse, Augsburg, Germany, a German Body Corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention concerns a double or single herringbone toothed power transmission gearing comprising a driving and driven gear each arranged coaxially relative to one another and meshing with several pairs of transfer gears mounted in the housing. The nature of the invention thus consists in the fact that the driving and driven gears acting as central gears are located radially merely by means of meshing with the pairs of transfer gears, which in turn are each divided into two herringbone toothed gears, and which, though non-rotatable relative to each other, are however flexibly or elastically interconnected. The flexible or elastic connection of the herringbone toothed transfer gears may be formed in accordance with the invention by means of splined couplings which render possible axial displacement of the gears relative to one another and angular displacement of their axes. Two of the splined couplings are herewith adapted to be adjustably fixed on the transfer gears associated thereto, to ensure on the one hand a satisfactory meshing between the central gears and the transfer gears and between the two gears of the transfer gear pairs on the other hand. On the other hand however it is also possible for elastic members in the form of elastic couplings to be provided between the two gears of the transfer gear pairs.

The central gears may in accordance with the invention be connected with the driving or driven shaft via articulated splined couplings or via elastic couplings.

The use of power transmission gears according to the invention is of particular advantage in cases where known stationary and epicyclic gears can no longer be employed owing to speeds being too high, or above certain transmission ratios, for example up to a ratio of 2:1.

In these cases the peripheral speeds and the centrifugal forces in the bearings of the planetary gears in epicyclic gears become too great. Normal stationary gears moreover take up considerable space which often is not available. The system of the transmission gear of the present invention is based on the fact that the moment of the drive shaft from the driving pinion is first transmitted to the first stage of several intermediate pinions, between which it is distributed so that these intermediate pinions only have to absorb a part of the turning moment, whereupon the second stage of the intermediate pinions delivers the turning moment to a driven pinion of the driven shaft. It is known herewith to use epicyclic gears as power transmission gears, in which the epicyclic gears fulfil the function of the intermediate pinions. These gears are limited with regard to their use, however, such limits originating from the high centrifugal force of the epicyclic gear carriers and from the restricted range of transmission ratios.

In order to permit maximum power to be transmitted, preference is given to a transmission gear having herringbone gearing and load pressure compensation. Such transmission gears have already been developed in practice and are in use in many cases, particularly where the transmission of large powers at high speeds is necessary. In one known arrangement, attempts have been made to obtain a uniform power distribution by the fact that two or more transfer gears which are mounted on a shaft parallel to the drive shaft, are interconnected by means of revolving rods and splined couplings. The

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load pressure compensation obtained thereby in the individual shafts is dependent upon the rotary elastic flexibility of the revolving torsion shafts. The elastic torque of the torsion shaft for technical reasons must not exceed a certain value, as otherwise excessively high stresses would lead to the risk of breakage. For this reason only limited power distribution can be obtained with this known device. In another known arrangement the power transmission is effected in that the two central gears and the individual geared halves are connected with the driving or driven shaft each by means of two double-geared couplings. This arrangement is very complicated and may be used only for limited transmission instances. Moreover, it is necessary for the driving and the driven shaft to be mounted in bearings, which in turn reduces the efficiency.

In particular, the power transmission, not always satisfactorily effected in known gears, is obtained by a great structural expenditure or by arranging complicated gear parts, which moreover bring about the risk of rapid wearing and cause a very rough operation of the gear.

In contradistinction to this, the structural expenditure of the gear in accordance with the invention is very low and far fewer components are used than in known gears, resulting in very low costs and operationally safe functioning. A substantial advantage of the invention consists particularly in the fact that the hitherto conventional central gear bearings are no longer required, so that, due to the bearing losses being eliminated, a far more favourable efficiency may be obtained with a gear in accordance with the invention. A further considerable advantage results from the extraordinarily great saving of space compared with known transmission gears, such as cannot be obtained by the stationary distribution gears already proposed.

Consequently there is obtained a very small specific weight and a very compact structure. Moreover a gear in accordance with the invention also has the advantage of coaxial shaft arrangement.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a longitudinal section on line I—I of Fig. 2 of the drawing, through a transmission gear, the central gears of which are connected with the driving or driven shaft via pairs of gears;

Fig. 2 is a cross section on the line II—II of Fig. 1;

Fig. 3 is a longitudinal section through a modification corresponding to Fig. 1 wherein the central gears are connected with the driving or driven shaft via revolving rods;

Fig. 4 is a diagrammatic side elevation of a known transmission gear in comparison with the distribution gear constructed in accordance with the invention; and

Fig. 5 is a diagrammatic front elevation of the gear corresponding to Fig. 4.

In accordance with Figs. 1 and 3, hollow shafts 13, which are radially equidistant from the axis of the central gears, are provided in a gear housing 12. Fig. 2 shows three such hollow shafts 13 arranged at angle of 120° relative to one another.

Pairs of transfer gears 2, 3 or 2^1, 3^1, which are in engagement with the central gears 1 and 4 arranged centrally (coaxially) relative to one another, are mounted on the hollow shafts 13 by means of bearings 14. The transfer gears 2 herewith mesh with the central gear 1, whereas the transfer gears 3 are in engagement with the other central gear 4.

In the case of herringboned gears it is necessary for them to be so arranged relative to one another that all gears are caused to be automatically aligned according to an axially fixed gear. In order, in the present case, to permit the self-alignment of the transfer gears 2 and 3 with the central gears 1 and 4, the transfer gears 2, 3 are divided and coupled with one another in an articulated manner. For connecting each pair of transfer gears 2 and 3 there are provided splined couplings 5 and 6, which permit axial movement of the two gears relative to one another and slight relative angular displacement of the transfer gears 2 and 3 yet in the peripheral direction ensure positive connection of the transfer gears.

For assembly reasons it is necessary for the position of the coupling 5, 6 relative to the operational gearing of the transfer gears 2, 3 to be equal in all pairs of transfer gears. This requirement is difficult to fulfil from a manufacturing point of view; and in accordance with a feature of the invention this can be remedied by the fact that two splined couplings 6 are designed as loose coupling rings, and after being positioned are drilled and located by pinning to one of the distributing gears. The position of the other splined coupling 5 relative to the operational gearing may be optional.

The pair of transfer gears 2^1, 3^1 is axially fixed by means of the two thrust bearings 15 and functions as a pair of guide gears. All the other transfer gears are positively located in relation to the guide gears 2^1, 3^1. The transfer gears are supported by bearing shafts 13 which are firmly anchored in the housing 12.

The end faces of the hollow bearing shafts are sealed by means of discs 11. Both central gears 1, 4 are floating and are located merely by engaging the transfer gears. The connection with the driving or driven shaft is effected either by means of articulated

splined couplings 7 and 8 (see Fig. 1) whereby the gears 1 and 4 are located both radially and axially merely by engagement with the transfer gears or by means of revolving flexible shafts 9 and 10 (see Fig. 3). In the latter case the revolving flexible shafts 9, 10 provide for the axial location of the gears, and the thrust bearings 15 are omitted.

If torque is applied to the gearing then all gears must be forcibly aligned axially with the teeth of the central gears 1, 4, which in turn are axially fixed in relation to the guide gear pair 2^1, 3^1. The floating central gears 1, 4 connected with the driving or driven shaft will be aligned under the load to balance the forces. Thus with the occurrence of errors in axle base and pitch errors, they will be radially displaced to such an extent until the tooth pressures in the individual tooth engagements are of equal magnitude. Due to the articulated connection with the shafts it is possible for the two central gears 1, 4 to be displaced slightly obliquely relative to their axis. This will occur when there are different errors in the tooth inclination. The distribution of power which is attained with this construction is carried out by a positive self-alignment to the equilibrium of forces of all gear elements participating in the transmission of torque. The saving of space caused by the gear in accordance with the invention is shown in Figs. 4 and 5. In these examples A illustrates a known transmission gearing without power distribution having the driving and driven shaft mounted coaxially relative to one another, in which the transmission gears B and C are mounted on a secondary shaft train relative to the driving and driven shaft.

The distribution gearing A^1 in accordance with the invention, which is also coaxial, takes up far less space, however, although it is adapted to transmit the same power and speed. This comparison of size, shown on the same scale in Figs. 4 and 5, is based on a technical example, in which an output of about 15000 h.p. at a speed reduction of about 20000 to 15000 revolutions per minute is to be transmitted. The gear in accordance with the invention provides a lower power to weight ratio, and due to the omission of the central gear bearings it gives a higher degree of efficiency, whilst maintaining a coaxial shaft disposition.

It will be appreciated that throughout the specification and claims reference to herringbone toothed gearing is to be understood as including double and single herringbone gearing.

WHAT WE CLAIM IS:—

1. A herringbone toothed gearing having a divided power transmission path comprising a driving and driven gear wheel each arranged coaxially relative to one another which mesh with several transfer gear pairs mounted in the housing, in which the two driving and driven gears acting as central gears are located radially merely by engaging with the pairs of transfer gears, these in turn being divided in such a manner that they each form two herringbone toothed gears, which, though non-rotatable relative to each other, are however interconnected in an articulated or elastic manner.

2. A gearing as claimed in Claim 1, in which the articulated or elastic connections, of the herringbone toothed transfer gears are formed by splined couplings acting between the gears, which couplings permit an axial displacement of the gears relative to one another and angular displacement of the gears.

3. A gearing as claimed in Claim 2, in which at least two of the splined couplings are adjustably mounted on the transfer gears associated therewith.

4. A gearing as claimed in any of the preceding claims, in which the central gears are connected with the driving or driven shaft via splined couplings and/or revolving flexible shafts.

5. A herringbone-toothed gearing having a divided power transmission path comprising a driving and driven gear each arranged coaxially relative to one another, which mesh with several transfer gear pairs mounted in the housing, constructed and arranged to operate substantially as herein described with reference to and as illustrated in Figs. 1, 2 and 3 of the accompanying drawings.

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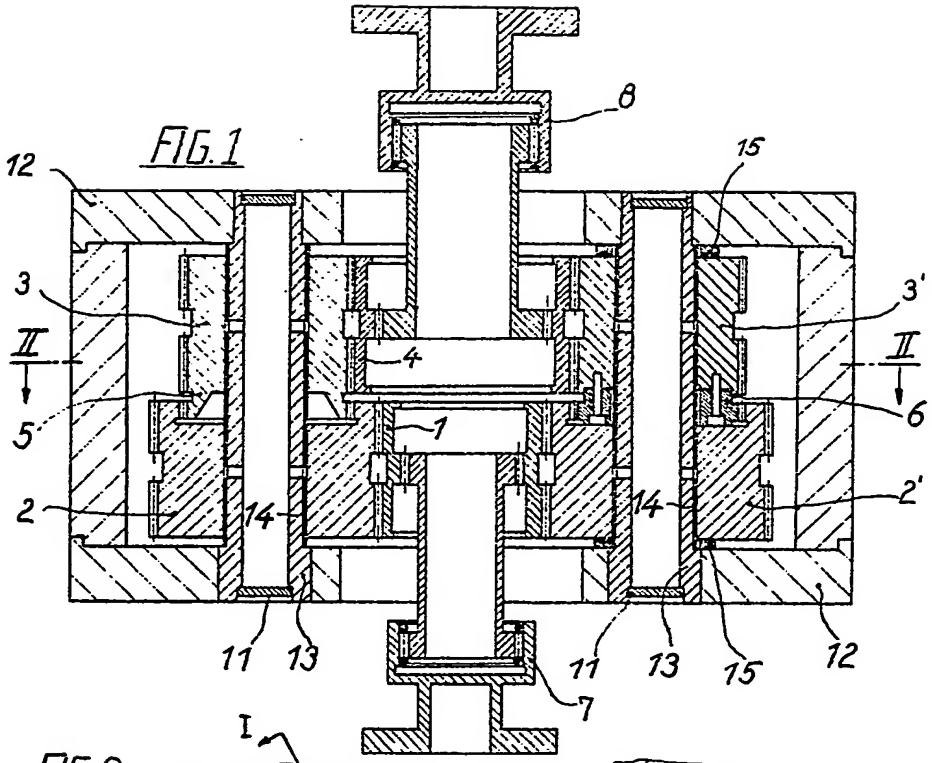
Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1962.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained

FIG.1


8
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15
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3'
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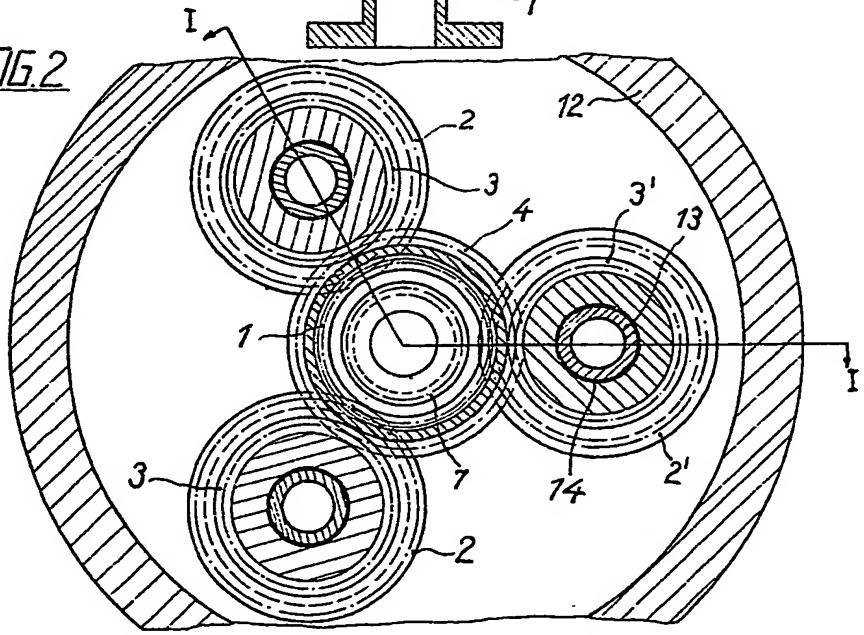
7

FIG.2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897,066 COMPLETE SPECIFICATION
2 SHEETS
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SHEETS 1 & 2

FIG. 3

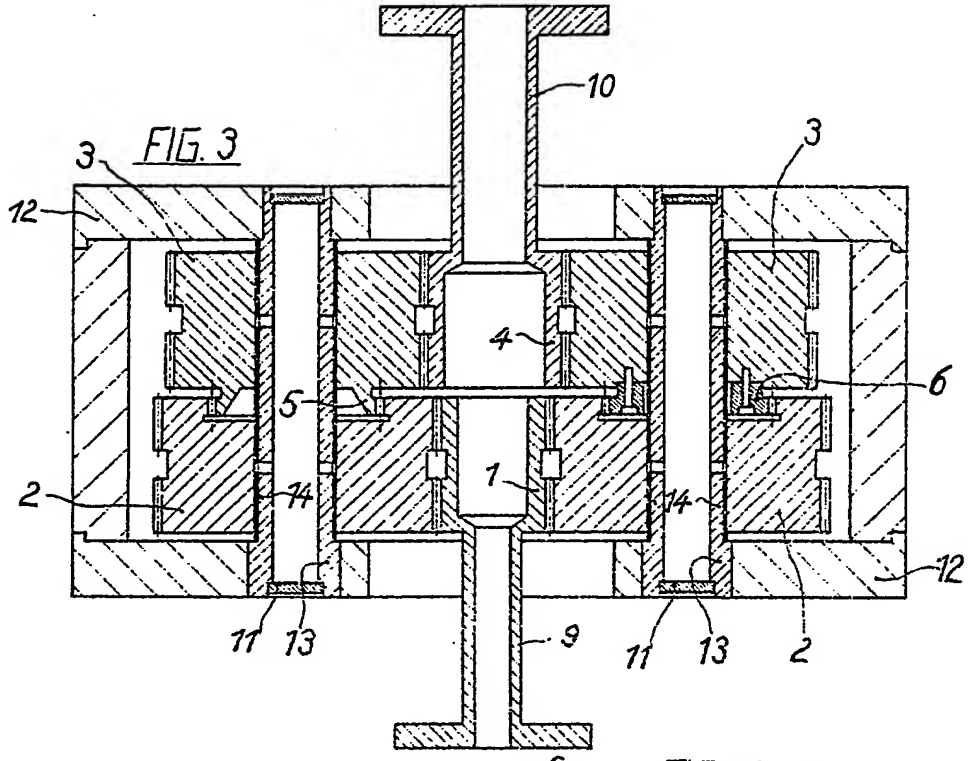
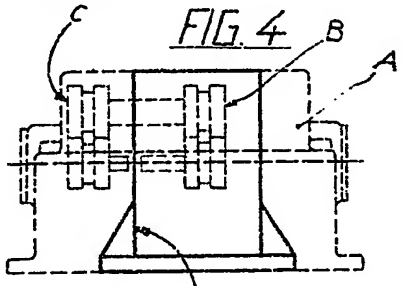


FIG. 4



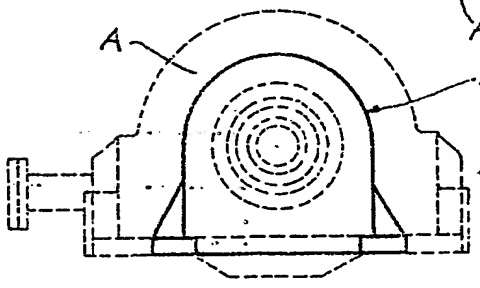


FIG. 5

897,066 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

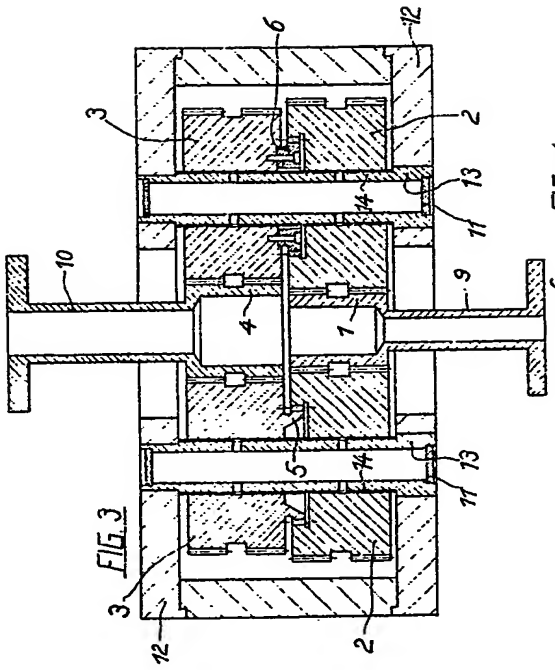


FIG.3

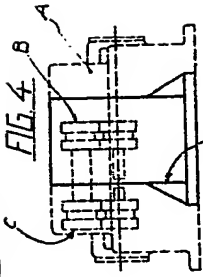


FIG.4

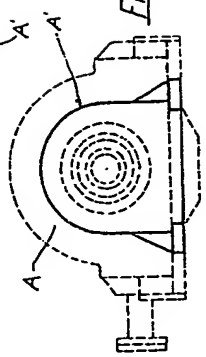


FIG.5

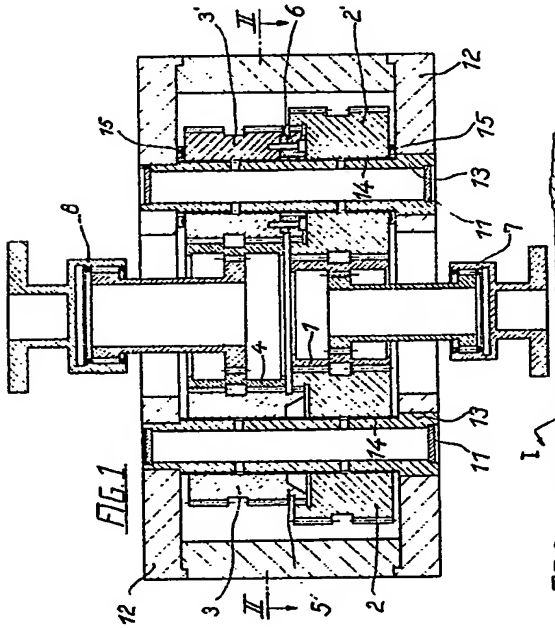


FIG.1

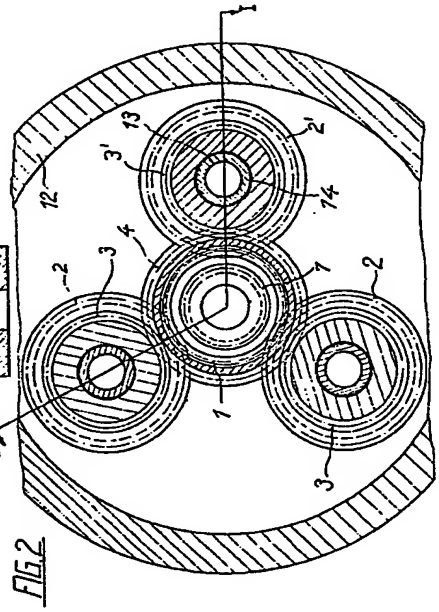


FIG.2

DOCKET NO: WWL-8664
SERIAL NO: 10/536,581
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